Common Murre (*Uria aalge*) attendance patterns at Cape St. Mary's, Newfoundland[1]

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Attendance patterns of common murres (*Uria aalge*) at Cape St. Mary's, Newfoundland, were observed during hatching to post-fledging periods of 1980 to 1984. Six study plots on breeding ledges (ca. 450 birds total) and a "club" on the water were monitored for seasonal fluctuations in numbers attending. Attendance on ledges was similar between years, being relatively stable from hatching through to median fledging, and declining steadily thereafter. Attendance at the club usually peaked between median hatching and fledging, then declined rapidly during the fledging period. Numbers of murres attending neighboring study plots were often significantly correlated, but correlations were much weaker between distant plots. There were few significant correlations between attendance and wind speed or tidal oscillations in any year of study. Numbers of murres attending individual study plots varied significantly between years; four declined, one increased, and one showed no significant change. Overall, there was a small decline in total numbers of murres attending all study plots between 1980 and 1984.

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La présence des Marmettes de Troïl (*Uria aalge*) au cap St. Mary's, Terre-Neuve, a fait l'objet d'observations de 1980 à 1984, de l'éclosion jusqu'après l'envol des oiseaux. Six surfaces d'échantillonnage sur les corniches de reproduction (*ca.* 450 oiseaux au total) et un «club» sur l'eau ont servi à l'étude et les fluctuations saisonnières du nombre d'oiseaux présents ont été enregistrées. La fréquence des oiseaux sur les corniches était semblable d'année en année; elle était relativement stable de l'éclosion jusqu'au milieu de la période d'envol, puis diminuait par la suite. La densité des oiseaux au «club» atteignait ordinairement son sommet du milieu de la période d'éclosion jusqu'à la période d'envol, puis diminuait rapidement au cours de la période d'envol. Il y avait corrélation significative entre les densités enregistrées sur des territoires avoisinants, mais les corrélations étaient beaucoup plus faibles lorsque les territoires étaient distants les uns des autres. Il n'y avait que peu de corrélations significatives entre la fréquence des oiseaux et la vitesse du vent ou les fluctuations des marées. Le nombre de marmettes présentes sur chaque surface d'échantillonnage variait significativement d'une année à l'autre : il y a eu diminution de densité sur quatre des surfaces, augmentation de densité sur une autre et il n'y a pas eu de changement significatif sur la dernière. De façon générale, il s'est produit une faible diminution du nombre total de marmettes entre 1980 et 1984.

[Traduit par la revue]

Introduction

Knowledge of seasonal and annual attendance patterns of murres (*Uria* spp.) at their breeding colonies is essential for monitoring changes in population size and status. In large colonies, samples of the population may be counted regularly through the breeding season to assess population changes between years (Birkhead and Nettleship 1980). Attendance at breeding ledges is determined mostly by the number of breeding adults (ordinarily at least one attending each egg or chick) and less so by prospecting subadults. Numbers vary seasonally with adult breeding chronology and activities, movement of nonbreeding prospectors between "clubs" and breeding ledges, weather, state of tide, and food availability (Birkhead 1978*b*; Slater 1980; Gaston and Nettleship 1981, 1982; Harris *et al.* 1983). Numbers of murres attending different colony areas are often correlated, suggesting that whatever factors control attendance (e.g., food availability) affect the colony as a whole (Birkhead 1978*b*; Gaston and Nettleship 1982).

Attendance patterns of common murres (*Uria aalge*) have not been reported for any colonies in Atlantic Canada, where over one million murres breed at a few sites in Newfoundland (Nettleship 1980). In this paper we present data recorded on attendance of common murres at Cape St. Mary's, Newfoundland, from 1980 to 1984. We examine synchrony of attendance at different locations within the colony, possible effects of winds and tide on attendance, and changes in the size and status of the murre population over the period of study.

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Study area and methods

Cape St. Mary's (46°50′ N, 54°12′ W) is located at the southwestern tip of the Avalon Peninsula of Newfoundland (Fig. 1). Near-vertical cliffs composed of stratified sedimentary rock rise 100–150 m above the sea and are lined with numerous broad and narrow horizontal ledges suitable for breeding by both common and thick-billed (*Uria lomvia*) murres. Most (ca. 80%) murres breed along a 500-m strip of coastline about 1 km east of a lighthouse situated at the head of the cape, and on or near a stack (Bird Rock) immediately adjacent to the mainland about 1.5 km east of the light (Fig. 1). The total breeding population of murres has been estimated at 10 000 and 1000 pairs of common and thick-billed murres, respectively (Nettleship 1980).

We used methods similar to those described by Birkhead and Nettleship (1980) for monitoring murres at Cape St. Mary's. Counts of total numbers of individual murres on selected breeding ledges were made on at least 30 or more days between the hatching period and the end of fledging in each year. A total of six plots (CM 1–6, Fig. 1) were established in 1980 for monitoring. Observations were made from 10 June to 13 August in 1980, from 26 May to 18 July in 1981, from 1 June to 8 August in 1982, from 31 May to 4 August in 1983, and from 1 June to 7 August in 1984. Counts were made between 13:00 and 16:00 Newfoundland Daylight Savings Time when attendance is most stable (Mahoney 1979; Birkhead and Nettleship 1980). To reduce variability

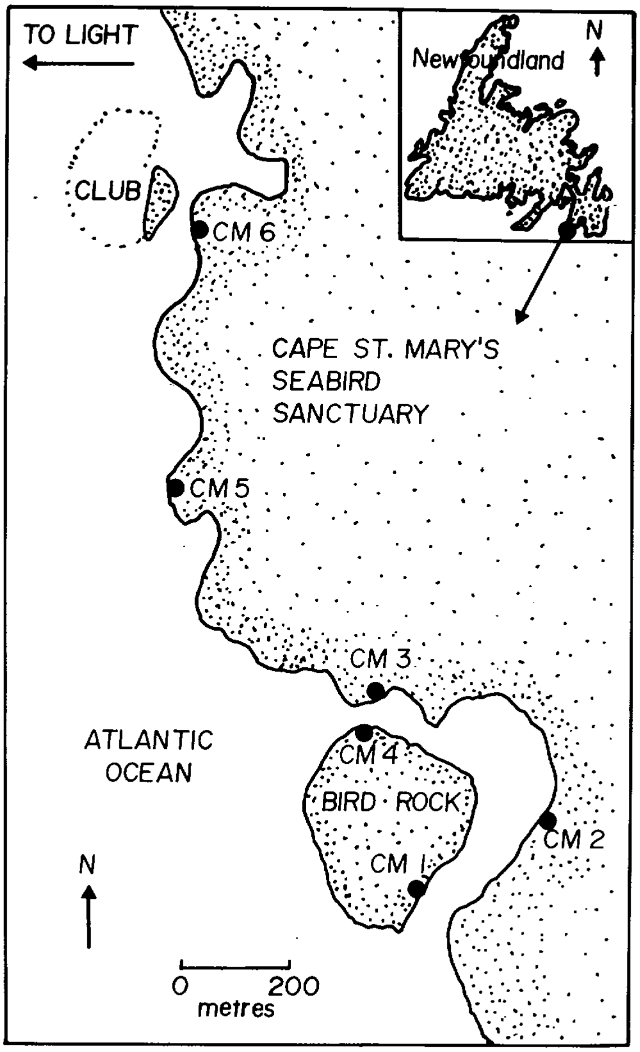

FIG. 1. Common murre study plots CM 1 to CM 6 and "club" area at Cape St. Mary's, Newfoundland.

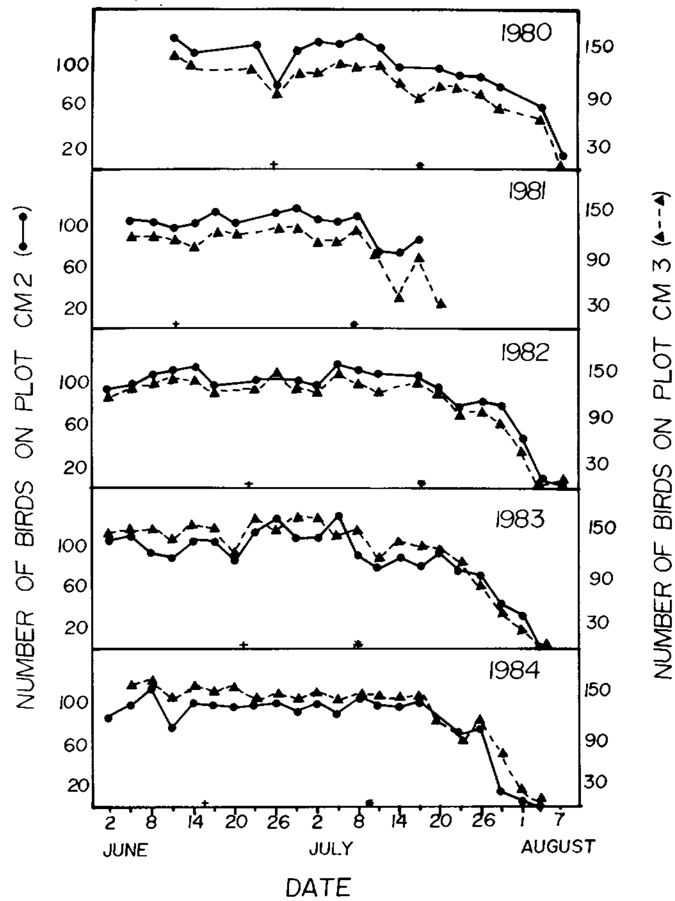

FIG. 2. Attendance patterns of common murres at study plots CM 2 and CM 3 (3-day means). Symbols along date axis indicate median hatching (+) and fledging (*) dates.

due to diurnal fluctuations in attendance, all plots were counted as quickly as possible once censusing began. Censusing normally required less than 1 h to complete, and was usually conducted every 1–3 days except under extreme rain or fog conditions. High winds alone did not preclude observations.

Although immature murres are morphologically similar to adults, their behaviour and consistent use of a "clubbing area" serve to distinguish them from breeding adults (Birkhead and Hudson 1977; McLagan 1981). Numbers of murres present in a club below the breeding ledges of plot CM 6 (Fig. 1) were also monitored in each year of study.

Results

Seasonal attendance patterns

The patterns of murre attendance at plots CM 2 and CM 3 (Fig. 2) and at all plots combined (Fig. 3) illustrate seasonal (hatching to fledging) trends for individual plots and the colony as a whole. In most years, attendance was fairly stable up to the start of the fledging period, and then declined over a 3-week period after the date of median fledging (hatching and fledging phenology data from R. L. McLagan and J. F. Piatt, unpublished data). Even near the date of median fledging, attendance at study plots remained near maximum levels (Fig. 3).

The number of murres attending the club varied markedly through summer in all years (Fig. 3). Attendance at the club usually decreased rapidly after fledging had commenced, but in 1983, it increased throughout fledging and then declined quickly towards the end of the fledging period.

Synchrony in attendance

Using only data collected up to median fledging in each year to remove any confounding effect of synchronized murre departure at the end of the breeding season, correlation analysis revealed that there were usually (in 13/15 or 87% of cases) significant correlations among attendance of murres at plots CM 1, 3, and 4 (Table 1). Numbers of murres on plot CM 2 were inconsistently correlated (significant in 7/15 or 47% of cases) with murre numbers on plots CM 1, 3, and 4. Murre attendance at plots CM 5 and 6 was significantly correlated in all years. However, correlations in attendance of murres at plots CM 1–4 with murres at plots CM 5 and 6 were low and rarely significant (in only 5/40 or 13% of cases).

On average, there was a strong correlation among attendance of murres at plots CM 1–4 (n = 30, mean r = 0.46 ± 0.042(SE)) which was improved considerably by dropping CM 2 from the analysis (n = 15, r = 0.55 ± 0.045). This was paralleled by a strong average correlation in attendance of murres at plots CM 5 and 6 (n = 5, r = 0.53 ± 0.058). The average correlation in attendance of murres at plots CM 1–4 versus CM 5 and 6, however, was significantly lower (n = 40, r = 0.28 ± 0.051) than the average correlation in attendance among plots CM 1–4 (after arcsine transformation, t = 2.76, df = 68, $p < 0.01$), but was not significantly different from the average correlation between plots CM 5 and 6 (arcsine

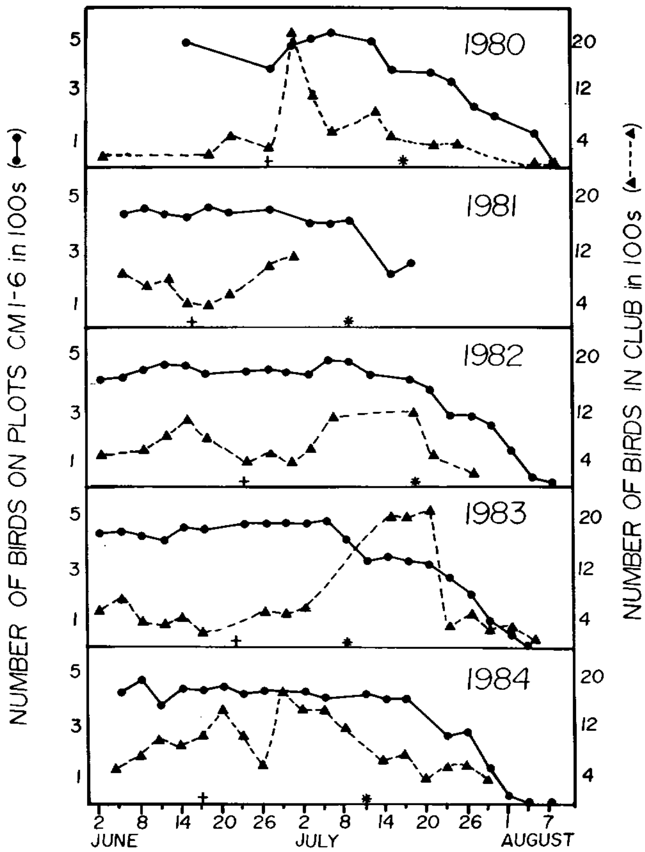

FIG. 3. Total attendance of common murres at all study plots (CM 1–CM 6) and at the "club" area (3-day means). Symbols along date axis indicate median hatching (+) and fledging (*) dates.

transformed, $t = -1.80$, df = 43, $p = 0.08$), partly because of the small number (5) of CM 5 and 6 correlations used in the analysis.

Effects of wind and tide

The effect of wind speed (maximum of 78 km/h) on attendance was examined using Spearman rank correlation analysis. Attendance at breeding ledges and in the club was poorly correlated with wind speed regardless of direction. Using only data up to median dates of fledging in any year, only 2 of 40 (5%) possible correlations were significant. When wind directions were partitioned into four 90° blocks and wind speed of a given direction was correlated with attendance, only 10 of 200 (5%) possible correlations were significant, of which half were negative and half were positive. Because the number of significant correlations did not exceed that expected by chance, it does not appear that wind had any significant effect on attendance of murres at ledges or in the club.

A similar analysis of the relationship between tide and attendance revealed that only 1 of 40 (2.5%) possible correlations between daily maximum tidal range and numbers in attendance was significant. Thus, it appears that seasonal tide cycles had little effect on attendance of murres at ledges or in the club.

Annual variations in attendance

Using only data collected up to median fledging in each year, the mean number of murres attending all plots and the club varied significantly between years (ANOVA, Table 2). Attendance at plots CM 1, 2, 4, and 5 was significantly lower in the last year (1984) than in the first year (1980) of study (Table 2). Attendance at plot CM 3 was significantly higher in 1984 than in 1980, whereas attendance at plot CM 6 was not significantly different after 5 years (Table 2).

TABLE 1. Annual and mean correlations (Pearson r) between numbers of common murres at different study plots at Cape St. Mary's using only data collected up to median fledging

	CM 2	CM 3	CM 4	CM 5	CM 6
CM 1					
1980	0.77**	0.87***	0.83***	0.71NS	0.54NS
1981	0.08NS	0.77****	0.36NS	0.49*	0.14NS
1982	0.38*	0.56***	0.58***	0.28NS	0.40NS
1983	0.33NS	0.42*	0.54*	0.15NS	0.40NS
1984	0.23NS	0.48**	0.39*	0.12NS	0.09NS
Mean	0.36	0.62	0.54	0.35	0.31
CM 2					
1980		0.69*	0.74*	0.78NS	0.38NS
1981		0.58**	0.51**	0.29NS	0.38NS
1982		0.14NS	0.20NS	−0.33NS	0.17NS
1983		0.44*	0.26NS	−0.17NS	−0.28NS
1984		0.08NS	0.08NS	−0.50**	−0.01NS
Mean		0.39	0.36	0.01	0.13
CM 3					
1980			0.75**	0.27NS	0.83NS
1981			0.51*	0.51*	0.21NS
1982			0.31NS	0.23NS	0.33NS
1983			0.53**	0.40NS	−0.13NS
1984			0.41*	0.21NS	0.34NS
Mean			0.50	0.32	0.31
CM 4					
1980				0.78NS	0.64NS
1981				0.61**	0.69**
1982				0.51*	0.28NS
1983				0.08NS	−0.09NS
1984				0.13NS	0.14NS
Mean				0.42	0.33
CM 5					
1980					0.65*
1981					0.64**
1982					0.58***
1983					0.43*
1984					0.35*
Mean					0.53

NOTE: The number of counts used each year were 11 (6 for CM 5 and CM 6) in 1980; 21 in 1981; 32 in 1982; 23 in 1983; and 30 in 1984.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
****$p < 0.0001$.

Total attendance also varied significantly between years (Table 2). The greatest change occurred between 1980 and 1981 with an 8.7% decrease in numbers attending. Mean numbers attending were significantly higher in 1980 than in any subsequent year, and significantly lower in 1981 than in any other year (Table 2). Altogether, the results indicate a slight but significant decline in attendance over the duration of the study, although there was no significant linear relationship ($r = -0.33$, df = 4, $p > 0.1$).

Attendance at the club also varied significantly between years. Using all data up to median fledging (Table 2), or using only the top eight counts of numbers attending because of highly erratic attendance patterns (ANOVA, $F = 3.1$, $p < 0.05$), it appears that there was a significant increase in club attendance

TABLE 2. Analysis of variance in the mean numbers of murres attending study plots and the "club" in 1980–1984 (using only data collected up to median fledging in each year)

						ANOVA		
	1980	1981	1982	1983	1984	F	P	S^a
CM 1	115	106	107	103	99	3.4	<0.05	–
CM 2	52	37	37	35	34	15.7	<0.0001	–
CM 3	128	123	138	154	144	15.8	<0.0001	+
CM 4	82	77	80	72	68	10.0	<0.0001	–
CM 5	48	48	44	46	41	4.0	<0.01	–
CM 6	45	44	39	43	46	7.1	<0.0001	=
Total	473	432	446	460	442	2.5	<0.05	–
BP[b]	289	276	250	281	278			
"Club"	717	618	625	423	1102	9.2	<0.0001	+

NOTE: Means with common underlining are not significantly different according to Student–Newman–Keuls multiple means test.

[a]Status, overall change in numbers after 5 years: –, decrease; +, increase; =, no change.

[b]BP, estimated number of murre breeding pairs; calculated by multiplying the no. of murres attending by the proportion of breeding pairs to total no. present (k-value) as determined from study plots CM 5 and 6 (range 0.56–0.64, R. L. McLagan and J. F. Piatt, unpublished data).

over the years of study, most of which occurred between 1983 and 1984.

Discussion

Seasonal trends in common murre attendance on breeding ledges at Cape St. Mary's were similar to those found by investigators in other regions (e.g., Tuck 1961; Birkhead 1978*b*; Slater 1980). Attendance patterns were generally similar between years, with the greatest variability occurring during fledging periods; possibly because of the irregular, weather-dependent fledging behaviour of murres (Tuck 1961; Mahoney 1979). In most years, attendance on ledges was near half maximum even when over 90% of chicks had fledged. This was probably because (*i*) one adult may remain at the breeding site for up to 2 weeks after its chick goes to sea (Birkhead 1978*a*), (*ii*) adults that lose eggs or chicks may stay long after their loss (Tschanz 1979), and (*iii*) nonbreeding and immature murres move late in the season from clubs to breeding ledges, where they prospect for future breeding sites (Birkhead and Hudson 1977; Birkhead 1978*a*). It is probably the third factor that accounts for the observed decline in club attendance during the fledging period (Birkhead and Hudson 1977).

Birkhead (1978*b*) found very high correlations in attendance of murres at three study plots on Skomer Island, Wales, during both incubation and nestling periods in one year. He offered this as evidence that all birds in the colony were responding to the same factors. Subsequent studies have been more ambiguous. Slater (1980) found high correlations in murre attendance at seven study plots in a colony at Copinsay, Scotland, during the prelaying period when murres exhibit cyclical attendance behaviour. During the incubation–nestling period, however, between-plot correlations in attendance were mostly insignificant. Similarly, Harris *et al.* (1983) found no strong correlations in attendance of murres at seven different plots on the Isle of May, Scotland, in June 1981.

At Cape St. Mary's, murre numbers at plots CM 5 and 6 were well correlated with each other in all years, but were poorly correlated with murre numbers at plots CM 1–4. This might be partially explained by the geographic segregation of plots CM 5 and 6 and CM 1–4 in the colony (Fig. 1) and suggests that factors affecting attendance operate at a scale larger than individual plots or cliffs, but smaller than the whole colony. We agree with Slater (1980) that "random factors, and factors singular to particular ledges" or areas of the colony may be important in determining individual plot attendance. There is also a possibility that attendance is influenced by social interactions operating at a local scale of visual range. In any case, this kind of variability must be considered in establishing both numbers and locations of study plots for population censusing.

Weather conditions, tidal rythms, and food availability may all influence patterns of murre attendance on breeding ledges (Corkhill 1971; Slater 1976, 1980; Birkhead 1978*b*; Gaston and Nettleship 1981, 1982). Most evidence suggests, however, that wind and tide effects are most pronounced during prelaying or incubation periods (Slater 1976, 1980; Birkhead 1978*b*; Harris *et al.* 1983). Only Birkhead (1978*b*) reported a significant negative correlation between wind speed and attendance during the incubation–nestling period in 1 of 2 years of study at Skomer Island. Gaston and Nettleship (1981) concluded that, except under extreme conditions, wind was not usually important in determining attendance of thick-billed murres at a colony in the Arctic. We found no significant effects of wind on attendance of common murres during the nestling–fledging period at Cape St. Mary's.

Slater (1980) found a significant relationship between state of tide and diurnal attendance patterns of common murres, but only during the prelaying period. We collected no data on diurnal variability in murre attendance. However, seasonal variability in prey abundance can be correlated with the magnitude of tidal oscillations (Frank and Leggett 1981; Piatt 1987), and therefore, if attendance is related to food availability (Gaston and Nettleship 1981, 1982), one might expect a relationship between murre attendance and tidal range. In this study conducted during the nestling–fledging period, however, we found no evidence for such a relationship.

The analysis of annual variance in attendance indicates there was a slight decline in murre attendance on breeding ledges at Cape St. Mary's over the period 1980–1984. As in the study reported by Harris *et al.* (1983), some plots showed a decline in attendance, while one showed an increase in attendance over time. This might represent nothing more than movement about the colony by individual birds, and may not be due to any real changes in the total population size (Harris *et al.* 1983). Furthermore, annual estimates of the proportion of attending murres actually breeding (R. L. McLagan and J. F. Piatt, unpublished data) suggest that there was relatively little variation (except for 1982) in the numbers of breeding murres at study plots between 1980 and 1985 (Table 2). Thus, annual variations in total attendance may have been caused largely by variations in attendance of nonbreeding prospectors on breeding ledges.

However, given that there are a number of serious mortality factors affecting murres at Cape St. Mary's, including hunting (Gaston *et al* 1983; Wendt and Cooch 1984), gill net entrapment (Piatt *et al.* 1984), and oil pollution (Piatt *et al.* 1985), monitoring is being continued to determine whether these mortality factors are having any significant impact on the murre population at Cape St. Mary's.

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BIRKHEAD, T. R. 1978*a*. Behavioural adaptations to high density nesting in the Common Guillemot *Uria aalge*. Anim. Behav. **26**: 321–331.

——— 1978*b*. Attendance patterns of Guillemots *Uria aalge* at breeding colonies on Skomer Island. Ibis, **120**: 219–229.

BIRKHEAD, T. R., and HUDSON, P. J. 1977. Population parameters for the Common Guillemot *Uria aalge*. Ornis Scand. **8**: 145–154.

BIRKHEAD, T. R., and NETTLESHIP, D. N. 1980. Census methods for murres, *Uria* spp.: a unified approach. Can. Wildl. Serv. Occas. Pap. No. 43.

CORKHILL, P. 1971. Factors affecting auk attendance in the pre-egg stage. Nat. Wales, **12**: 258–262.

FRANK, K. T., and LEGGETT, W. C. 1981. Wind regulation of emergence times and early larval survival in capelin (*Mallotus villosus*). Can. J. Fish. Aquat. Sci. **39**: 991–1003.

GASTON, A. J., and NETTLESHIP, D. N. 1981. The Thick-billed Murres (*Uria lomvia*) of Prince Leopold Island–a study of the breeding ecology of a colonial high arctic seabird. Can. Wildl. Serv. Monogr. Ser. No. 6.

——— 1982. Factors determining seasonal changes in attendance at colonies of the Thick-billed Murre *Uria lomvia*. Auk, **99**: 468–473.

GASTON, A. J., GOUDIE, R. I., NOBLE, D. G., and MACFARLANE, A. 1983. Observations on "turr" hunting in Newfoundland: age, body condition, and diet of Thick-billed Murres (*Uria lomvia*), and proportions of other seabirds killed off Newfoundland in winter. Can. Wildl. Serv. Prog. Note No. 141.

HARRIS, M. P., WANLESS, S., and ROTHERY, P. 1983. Assessing changes in the number of Guillemots *Uria aalge* at breeding colonies. Bird Study, **30**: 57–66.

MAHONEY, S. P. 1979. Breeding biology and behaviour of the Common Murre (*Uria aalge aalge* (Pont.)) on Gull Island, Newfoundland. M.Sc. thesis, Memorial University of Newfoundland, St. John's.

MCLAGAN, R. L. 1981. Aspects of the social behaviour of juvenile Common Murres (*Uria aalge aalge* (Pont.)) on Gull Island, Newfoundland. B.Sc. (Hon.) thesis, Memorial University of Newfoundland, St. John's.

NETTLESHIP, D. N. 1980. A guide to the major seabird colonies of eastern Canada: identity, distribution and abundance. Can. Wildl. Serv. Manuscr. Rep. No. 97.

PIATT, J. F. 1987. Behavioural ecology of Common Murre and Atlantic Puffin predation on capelin: implications for population biology. Ph.D. thesis, Memorial University of Newfoundland, St. John's.

PIATT, J. F., NETTLESHIP, D. N., and THRELFALL, W. 1984. Net-mortality of Common Murres and Atlantic Puffins in Newfoundland, 1951–1981. *In* Marine birds: their feeding ecology and commercial fisheries relationships. *Edited by* D. N. Nettleship, G. A. Sanger, and P. F. Springer. Can. Wildl. Serv. Spec. Publ. pp. 196–206.

PIATT, J. F., ELLIOT, R. D., and MACCHARLES, A. 1985. Marine birds and oil pollution in Newfoundland, 1950–1984. Newfoundland Inst. Cold Ocean Sci. Rep. No. 105.

SLATER, P. J. B. 1976. Tidal rhythm in a seabird. Nature (London), **264**: 636–638.

——— 1980. Factors affecting the numbers of Guillemots *Uria aalge* present on cliffs. Ornis Scand. **11**: 155–163.

TSCHANZ, B. 1979. Helfer-beziehungen bei Trottellummen. Z. Tierpsychol. **49**: 10–34.

TUCK, L. M. 1961. The murres. Can. Wildl. Serv. Monogr. Ser. No. 1.

WENDT, S., and COOCH, F. G. 1984. The kill of murres in Newfoundland in the 1977–78, 1978–79, and 1979–80 hunting seasons. Can. Wildl. Serv. Prog. Note No. 146.